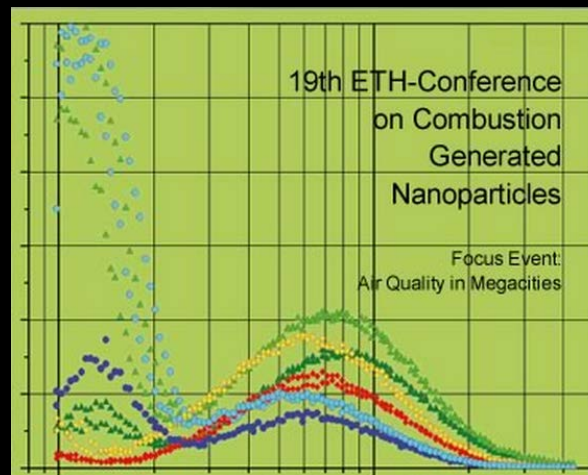


OUTDOOR AND INDOOR PARTICLE CONCENTRATIONS IN SCHOOLS OF BARCELONA DURING THE BREATHE STUDY

QUEROL X.¹, RIVAS I.^{1,2}, BOUSO L.², RECHE C.², AMATO F.¹, VIANA M.¹, MORENO T.¹,
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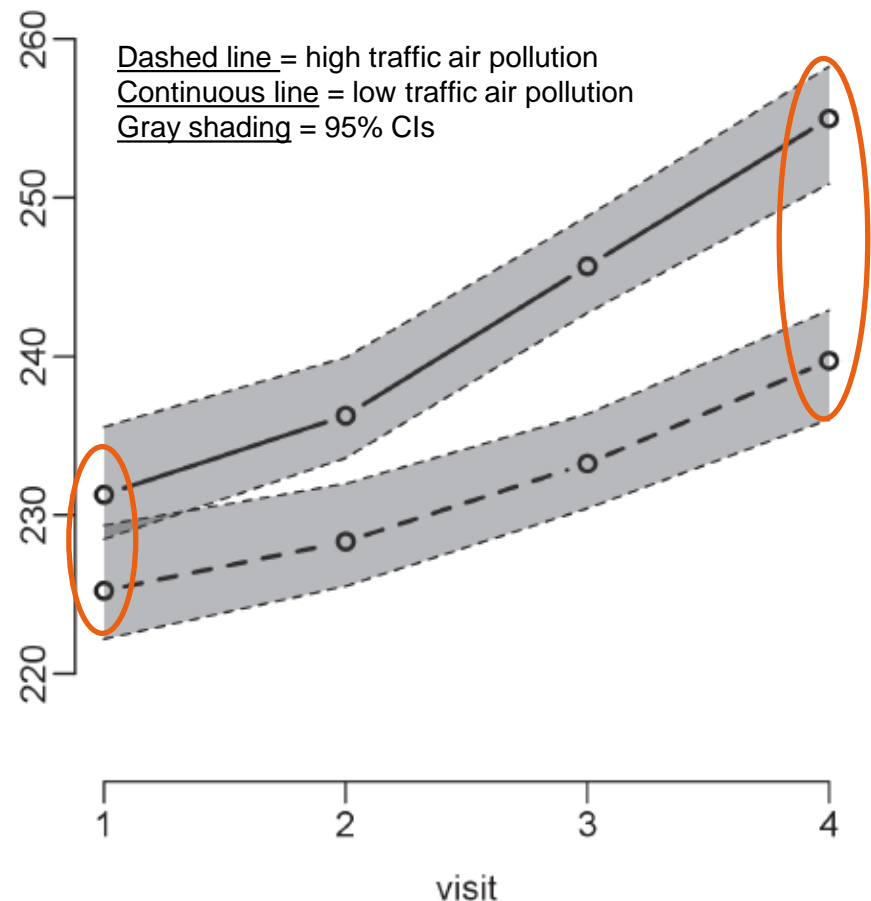
Zurich, 30th June 2015

Exposure to air pollution at school

Association between Traffic-Related Air Pollution in Schools and Cognitive Development in Primary School Children: A Prospective Cohort Study

Jordi Sunyer^{1,2,3,4}, Mikel Esnaola^{1,2,3}, Mar Alvarez-Pedrerol^{1,2,3}, Joan Fornes^{1,2,3}, Ioar Rivas^{1,2,3,5}, Mònica López-Vicente^{1,2,3}, Elisabet Suades-González^{1,2,3,6}, Maria Foraster^{1,2,3}, Raquel Garcia-Esteban^{1,2,3}, Xavier Basagaña^{1,2,3}, Mar Viana⁵, Marta Cirach^{1,2,3}, Teresa Moreno⁵, Andrés Alastuey⁵, Núria Sebastian-Galles², Mark Nieuwenhuijsen^{1,2,3}, Xavier Querol⁵

PLoS Med. 2015;12(3):e1001792



Objectives on ambient air & exposure



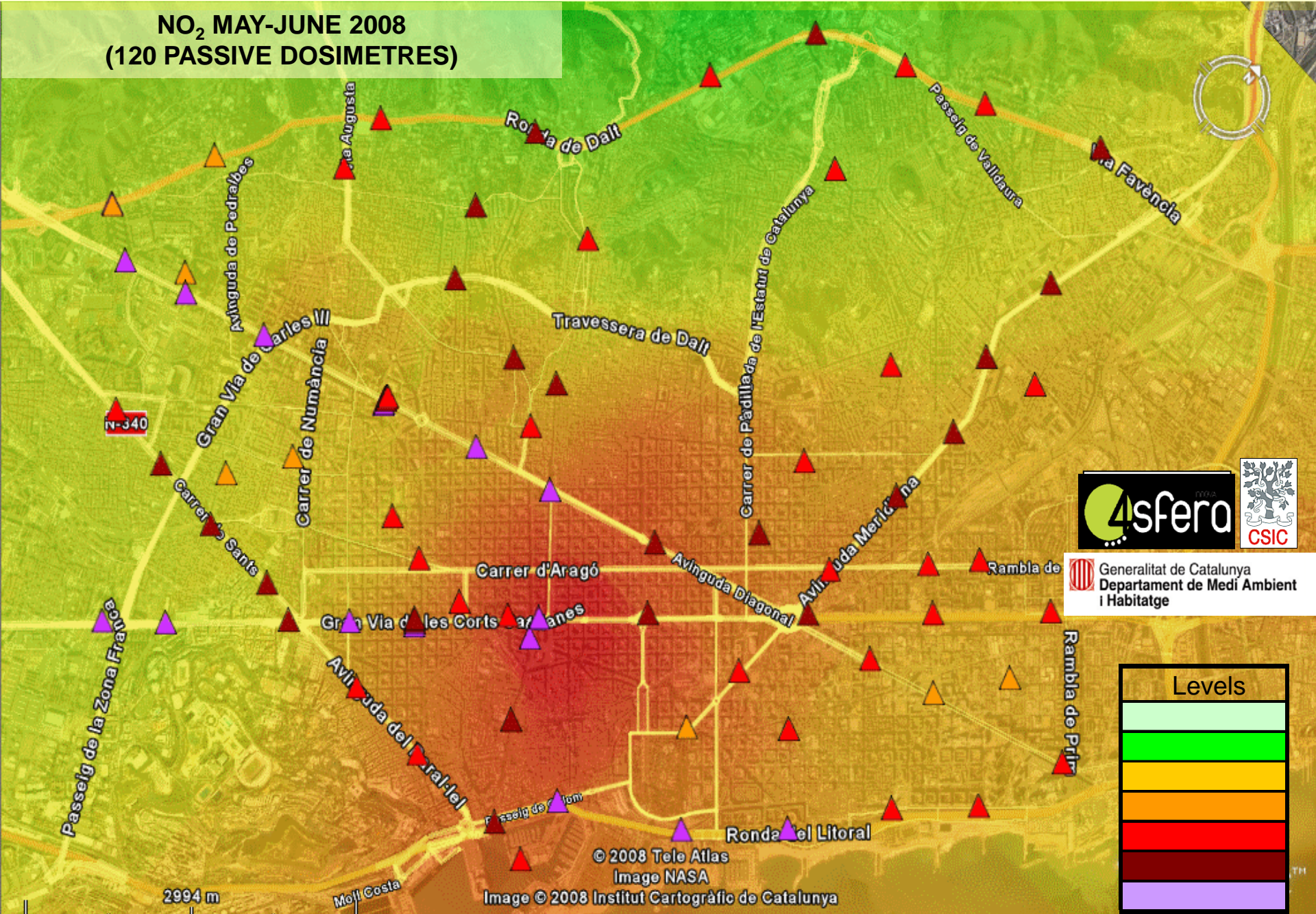
**ERC-Advanced Grant,
Leader of the exposure studies:
Xavier Querol, IDAEA-CSIC**

- Characterizing children exposure to urban air pollutants in schools
- Identification and quantification of the main sources of these pollutants affecting indoor and outdoor environments
- Defining factors affecting PM (including UFP) levels and composition in both indoor and outdoor environments: road traffic emissions, ventilation and type of playground
- Characterize children's daily BC exposure and sources



Metodology: Study area

NO₂ MAY-JUNE 2008
(120 PASSIVE DOSIMETRES)



Generalitat de Catalunya
Departament de Medi Ambient
i Habitatge

Levels
Light Green
Bright Green
Yellow
Orange
Red
Purple

© 2008 Tele Atlas
Image NASA
Image © 2008 Institut Cartogràfic de Catalunya

2994 m

Moll Costa



Methodology: Measurements

Measurement periods

1. February to June 2012
2. September 2012 to February 2013

36 schools in Barcelona

3 schools in Sant Cugat

INDOOR

Monitoring sites

OUTDOOR



- Two **simultaneous** schools & a **urban background reference station** of Palau Reial (**UB**)
- Simultaneously in **indoor** and **outdoor** school environments
- Sampling in **teaching hours** (9 to 17h), from Monday to Thursday
- **2 campaigns at each school:**
 - 1 week/school in winter-spring
 - 1 week/school in fall-winter

Metodology: Measurements & sampling

SCHOOLS

DUSTTRAK DRX

HIGH-VOLUME SAMPLERS

MICROAETH® AE51

MINIDISC

GRADKO NO₂ TUBES

PM_{2.5}

PM_{2.5} COMPONENTS

BC

N

SIZE

LDSA

NO₂

UB REFERENCE SITE

GRIMM

HIGH-VOLUME SAMPLERS

MAAP

WCPC

NSAM

GRADKO NO₂ TUBES

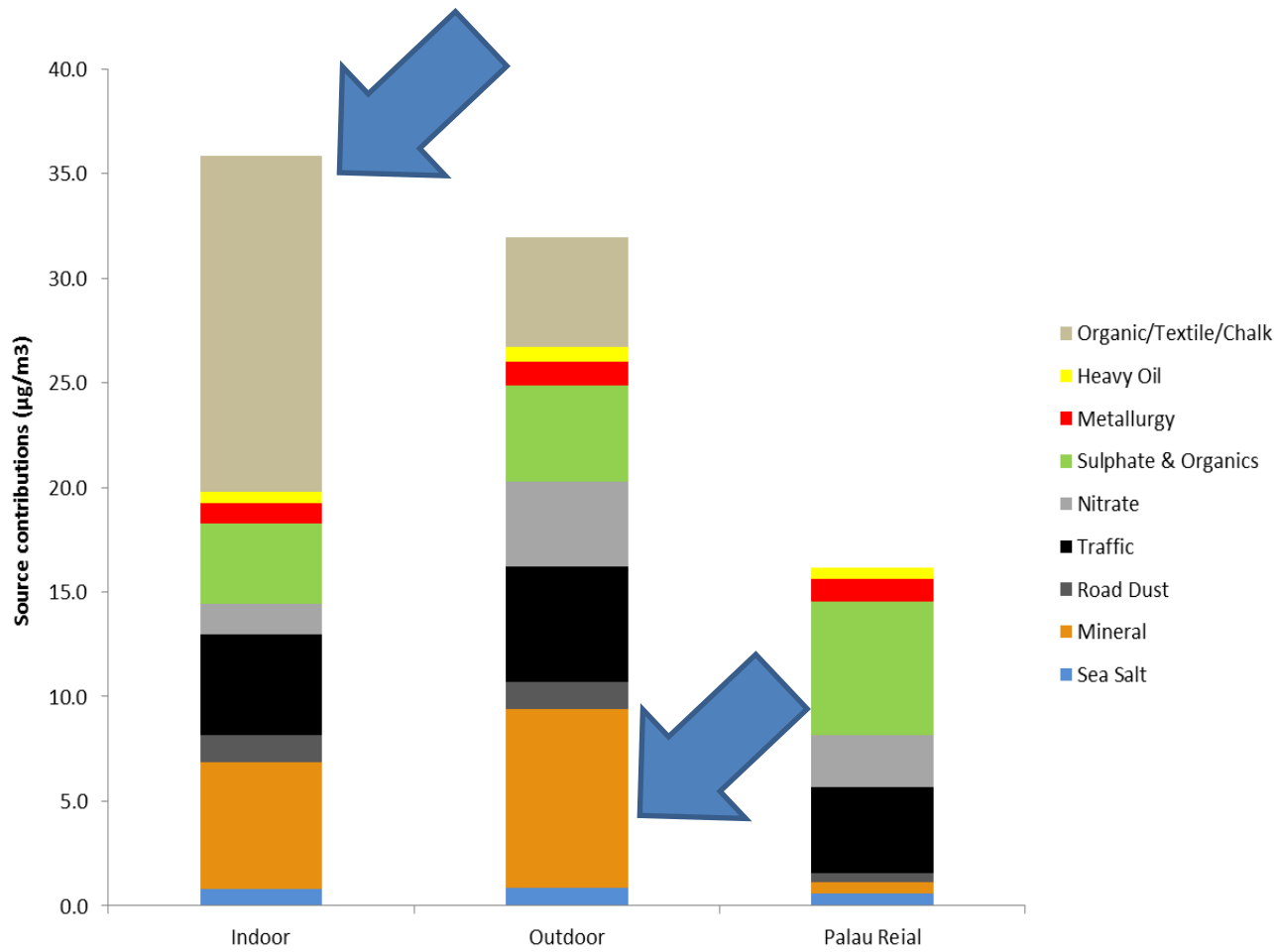
Results: Mean levels

	INDOOR		OUTDOOR		UB REF. STATION	
	Mean	SD	Mean	SD	Mean	SD
NO₂ ($\mu\text{g}\cdot\text{m}^{-3}$)	30	13	47	19	41	20
PM_{2.5} ($\mu\text{g}\cdot\text{m}^{-3}$)	37	16	29	24	17	8
N ($\text{pt}\cdot\text{cm}^{-3}$)	15625	6673	23614	9514	14665	6034
EBC ($\mu\text{g}\cdot\text{m}^{-3}$)	1.3	0.9	1.4	1.1	1.3	0.8

NO₂ outdoor levels for the rest of schools in Barcelona = 50 $\mu\text{g}\cdot\text{m}^{-3}$

- High levels of PM_{2.5} in schools → Local (school) emission of PM_{2.5}
- Mean levels of pollutants are intermediate between traffic and urban background sites

Results: PM2.5 source apportionment



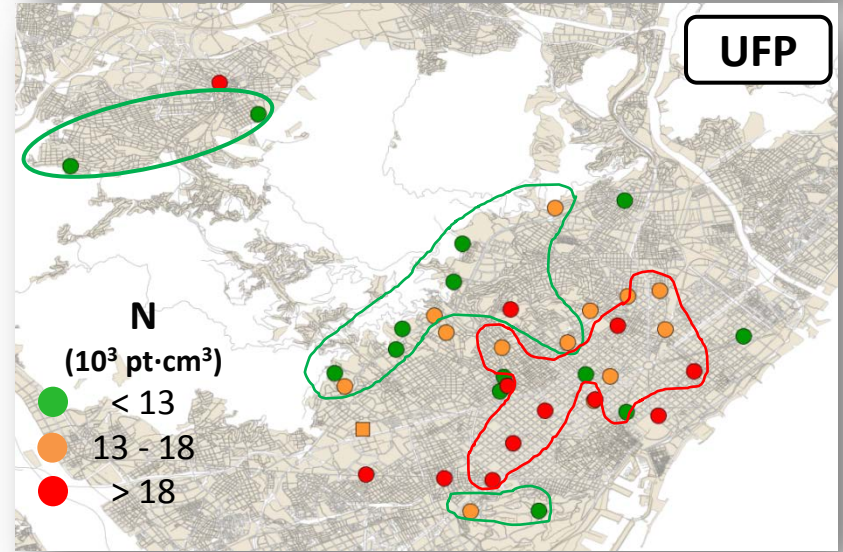
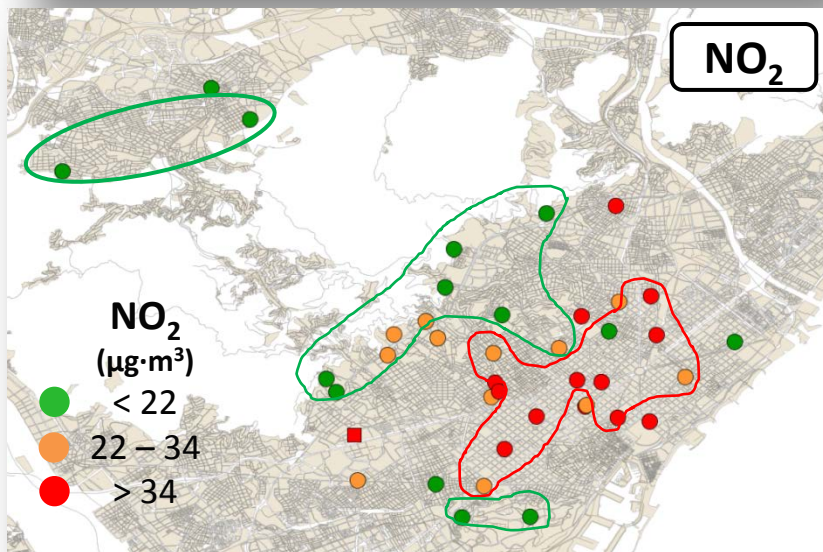
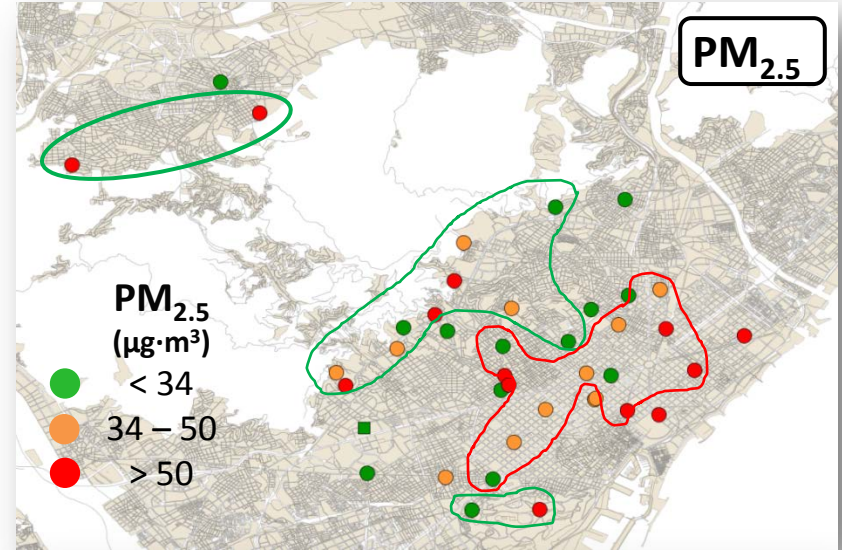
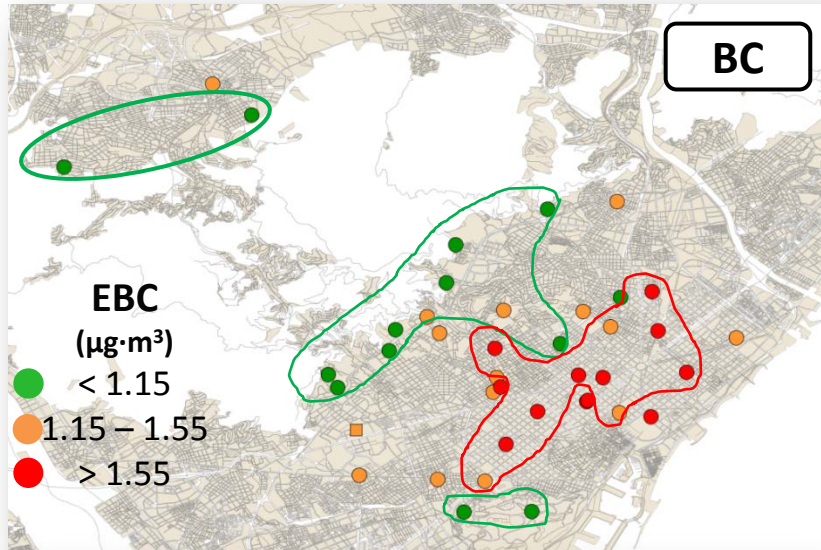
Results: Spatial variation

INDOOR

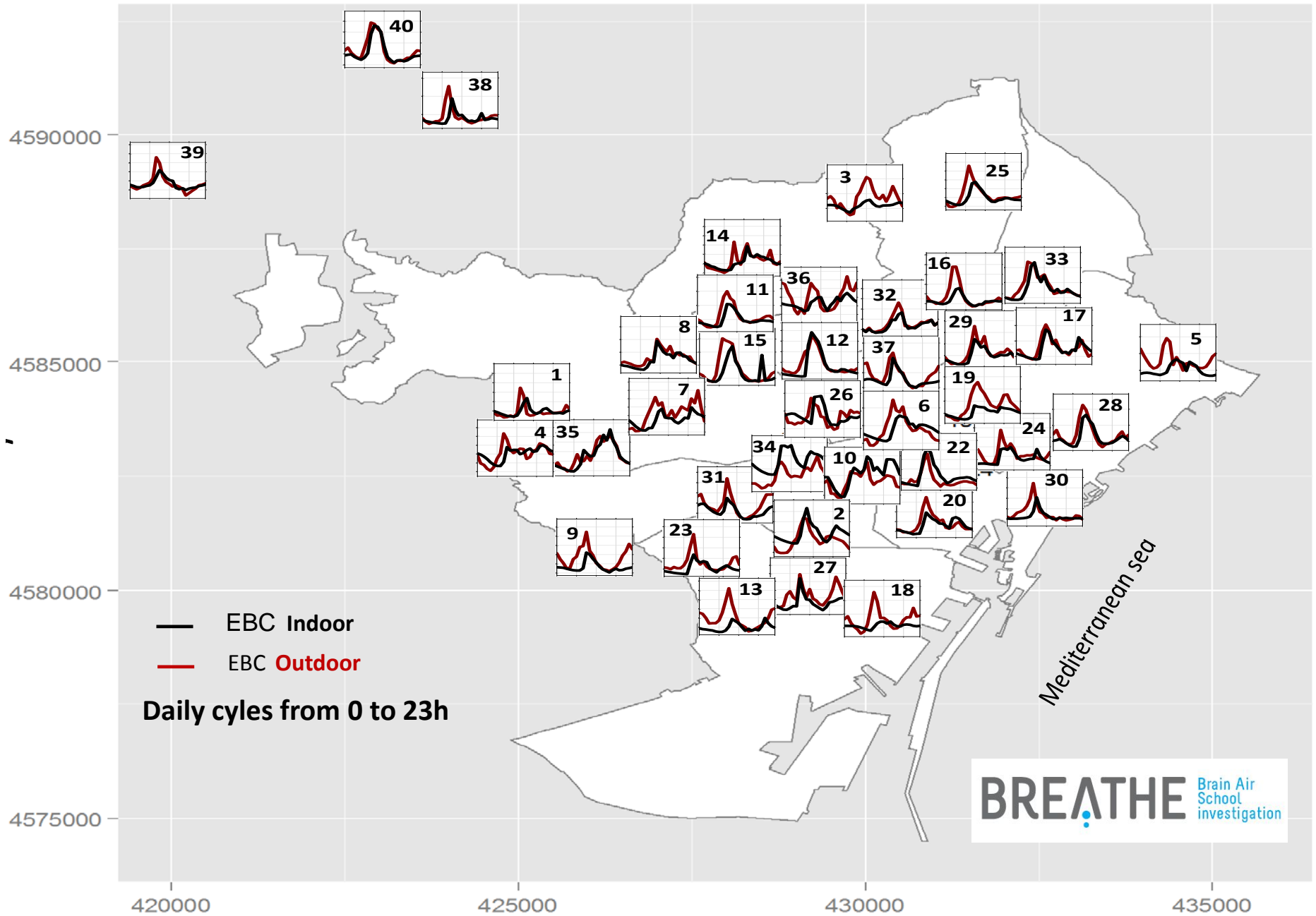
○ Escoles BREATHE □ Estació referència

EC levels perimeter

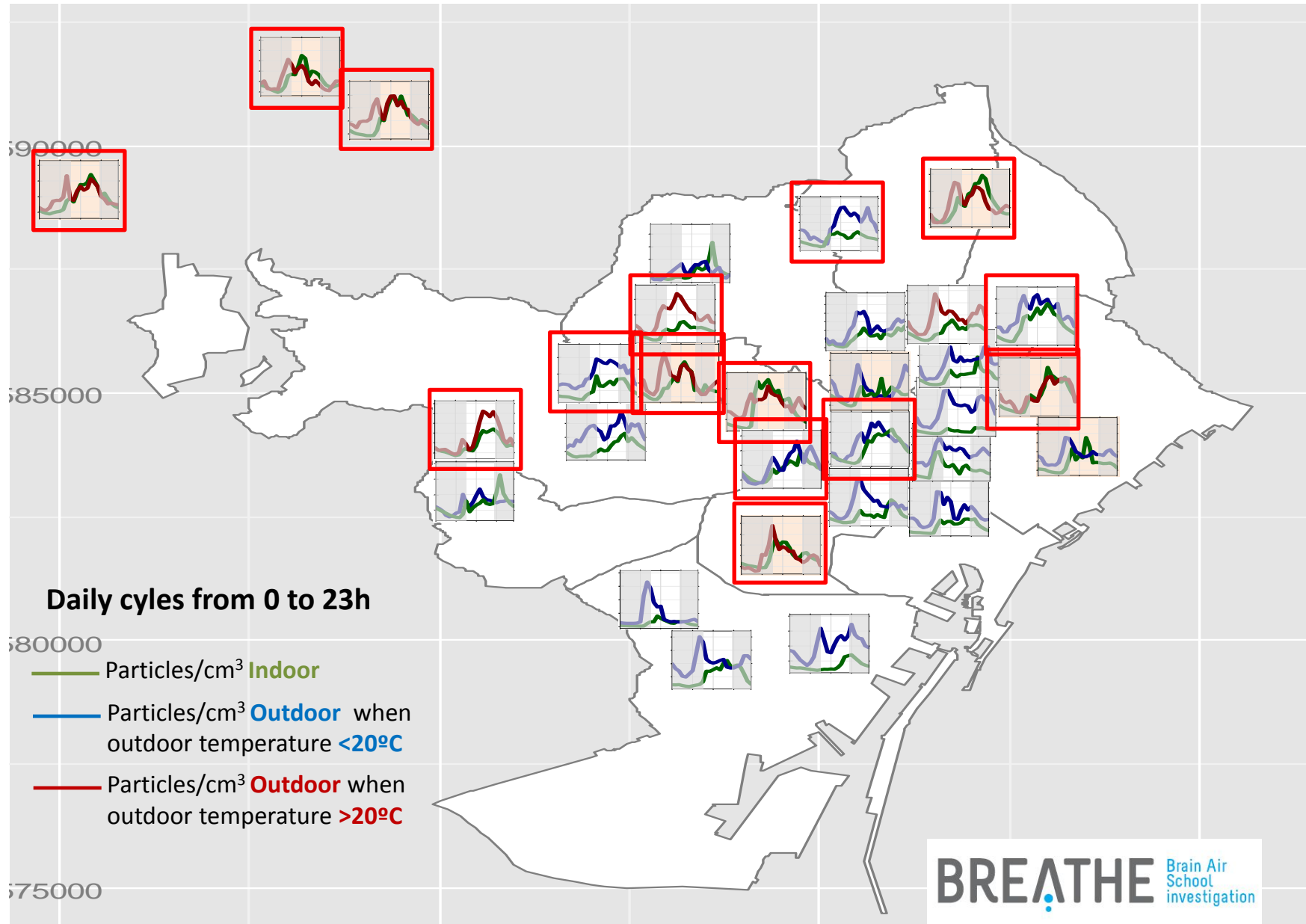
— Low
— High



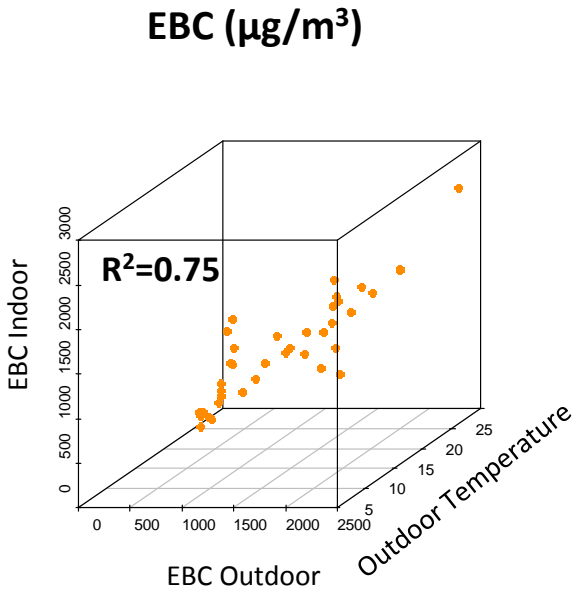
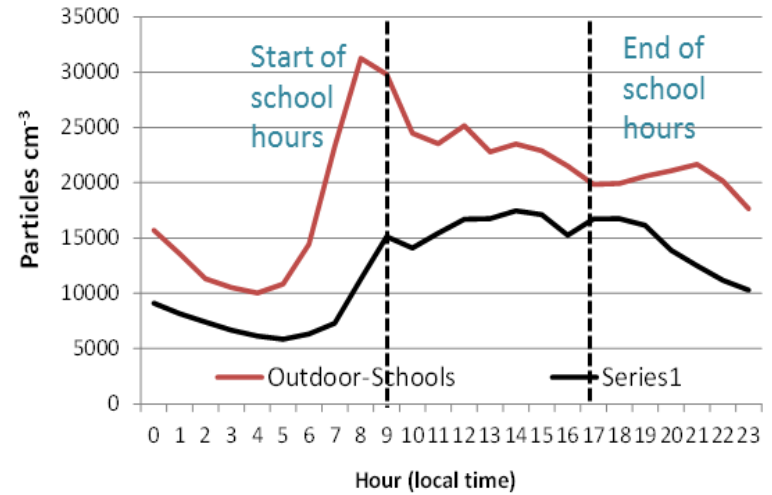
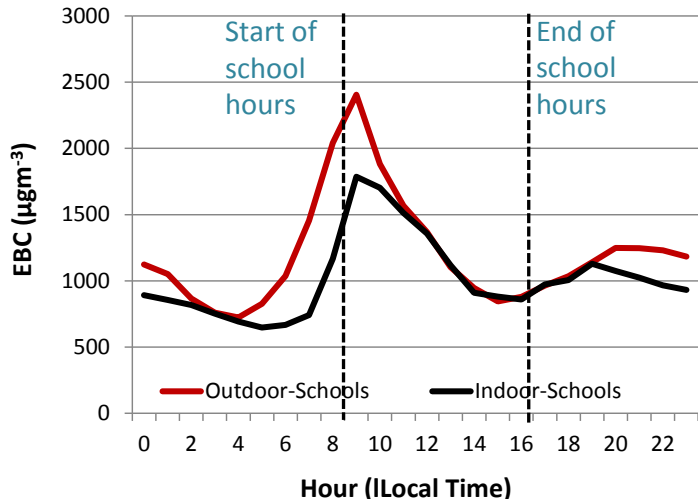
Results: Levels of BC



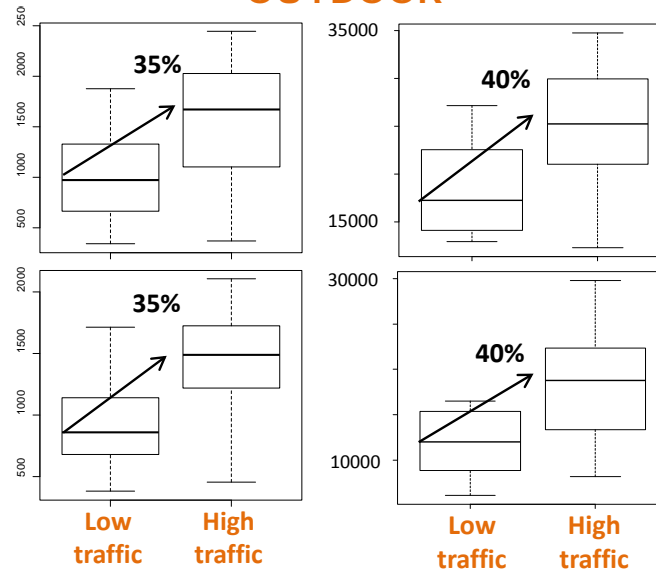
Results: Levels of ultrafine particles



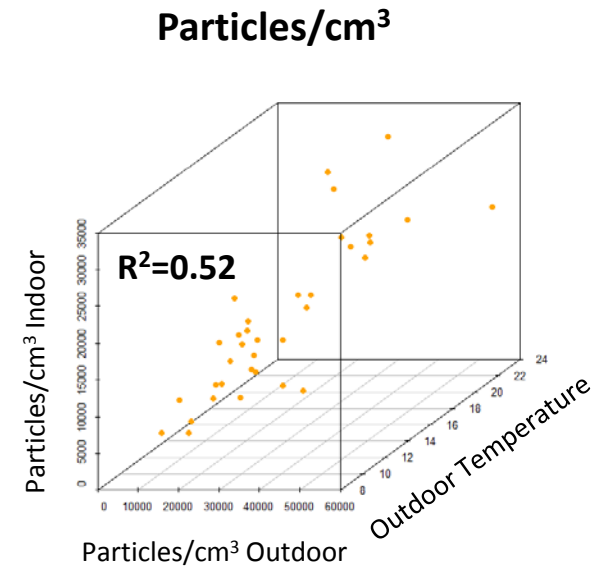
Results: Levels of BC & ultrafine particles



OUTDOOR

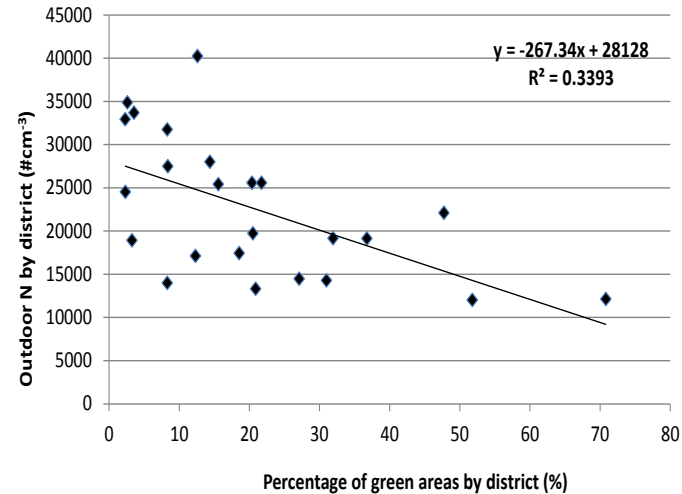
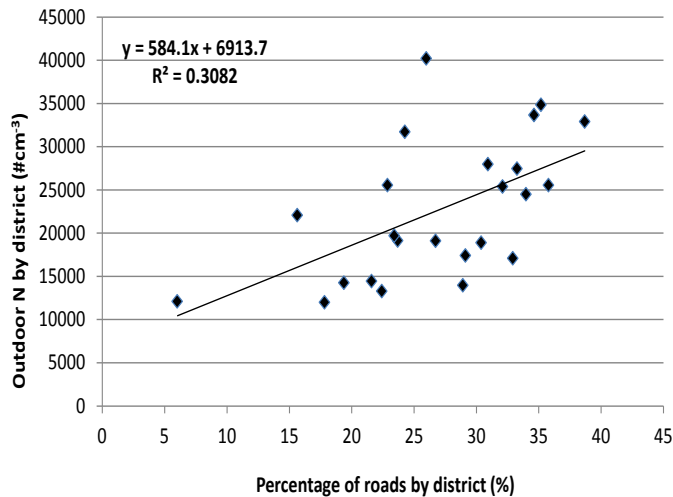
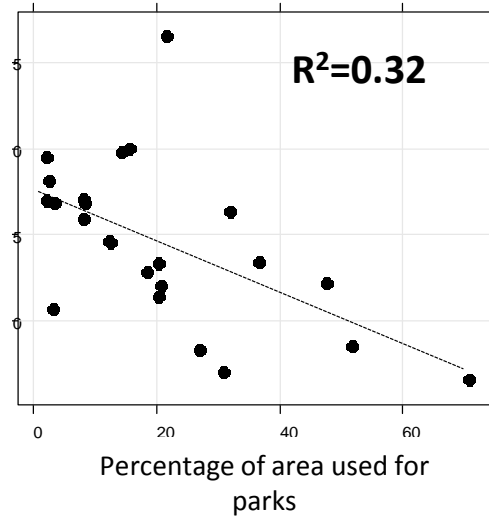
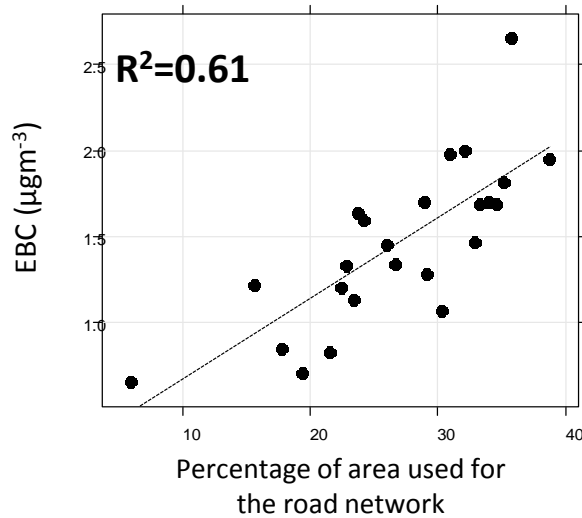


INDOOR



Results: Levels of BC & ultrafine particles

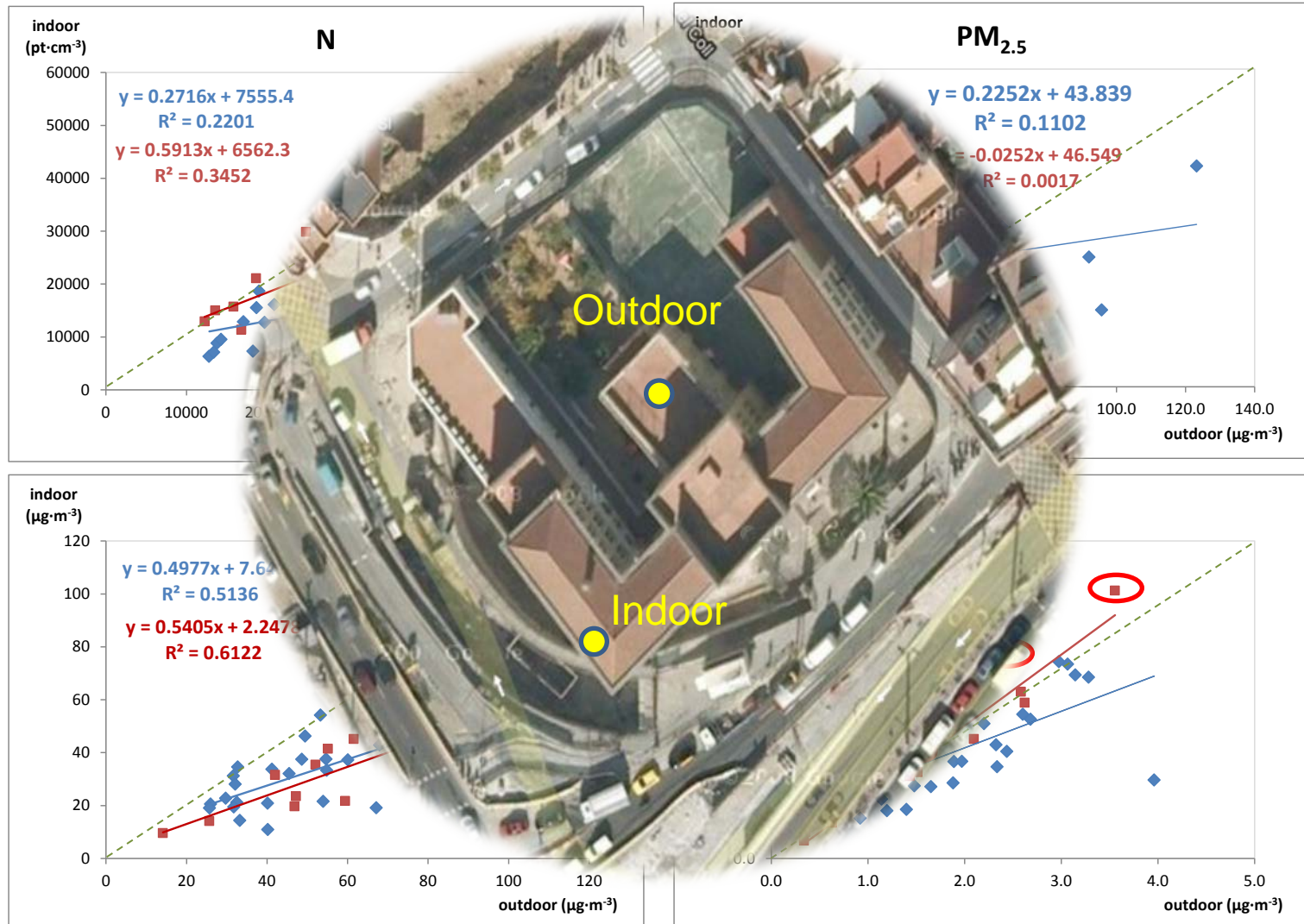
Correlation between average **EBC levels** and **ultrafine particle concentrations** at different districts of the city of Barcelona and the percentage of surface area used for the **road network** and for **parks**



Results: Infiltration of pollutants

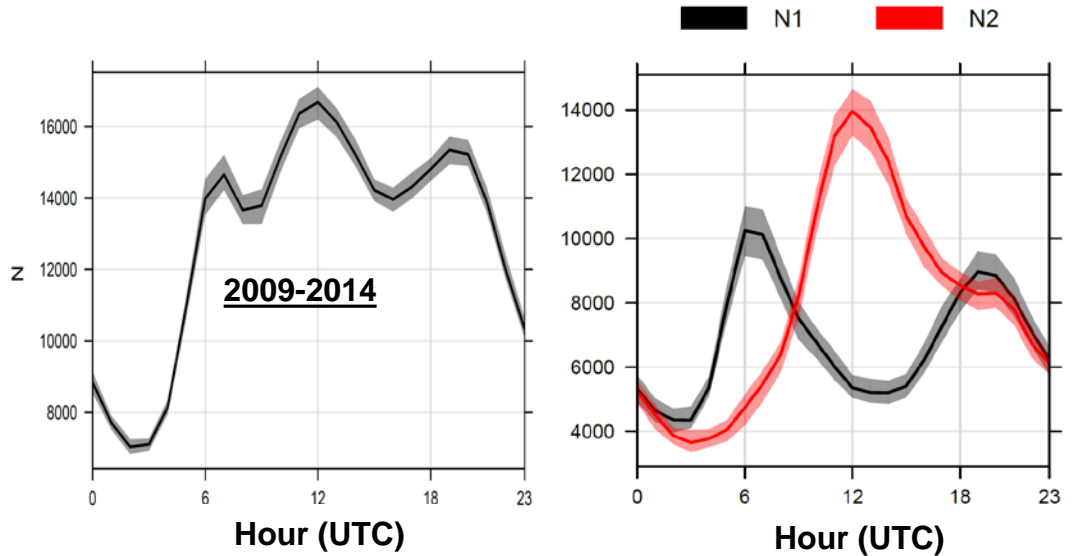
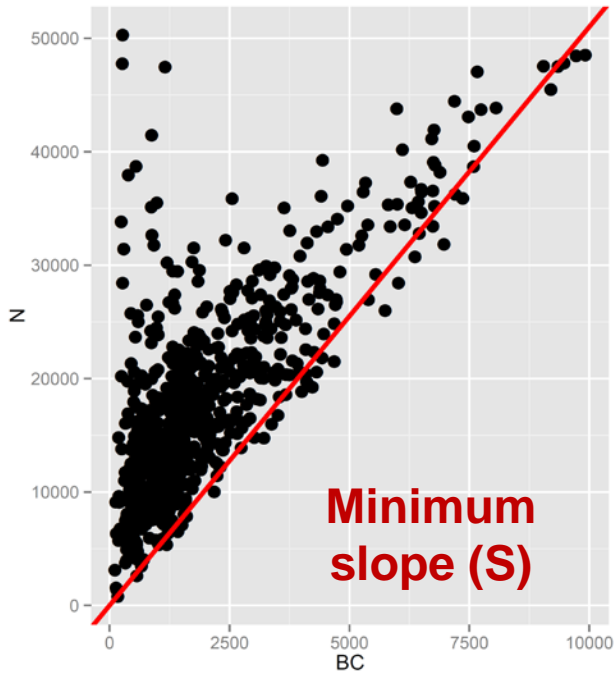
◆ Closed windows

■ Opened windows

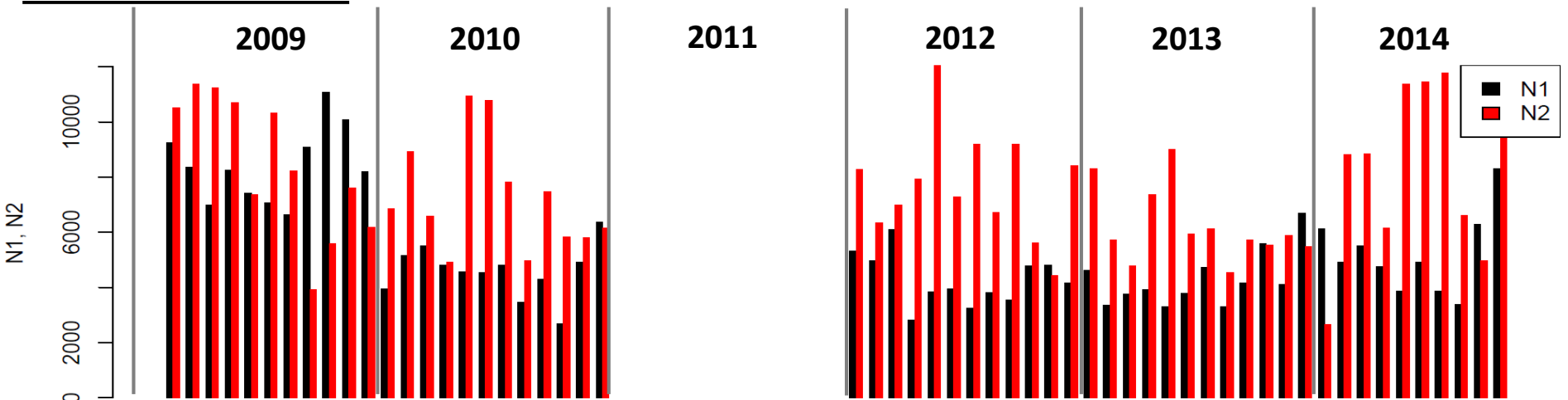


Outdoor measurements carried out more distant from highly trafficked roads than indoor measurements

Contribution of minimum primary emissions (N1) and new particle formation enhancements (N2) in Barcelona urban environment



MONTHLY AVERAGES



Rodríguez and Cuevas (2007)

Conclusions

- Schools in Barcelona have high levels of pollutants because most of them are very close to highly traffic streets. Outdoor levels are intermediate between those from traffic and urban background air quality monitoring sites
- PM_{2.5} is an exception, the influence of sand playgrounds as well as indoor organic emissions from clothes and skin of children accounts for higher PM_{2.5} levels than in traffic sites
- BC levels are governed by road traffic, with 35% higher levels in high traffic schools
- UFP increase also by 40% as a mean in high traffic schools, but in most of the schools photochemically generated secondary UFPs highly contribute at midday when BC is at the lowest. We are currently investigating health effects of primary and secondary UFP
- In spite of this secondary generation of UFP, both UFP and BC show an inverse correlation with green areas and a direct correlation with the area used by traffic

Thank you very much for you attention!

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BREATHE

Brain Air
School
investigation

idæ^a



National Plan for R+D+i



xavier.querol@idaea.csic.es

ERC-AG-BREATHE

